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1 INTRODUCTION

The LA amplified controllers provide libraries of presets dedicated for use of L-ACOUSTICS® products. A factory preset combines the control of speaker parameters and the application targets of the speaker. As a result, a preset allows the loudspeaker to match a given application when arranged into a given configuration. Multiple configurations exist from single distributed to line source array systems.

However, as the number of available factory presets is not infinite, the frequency response of the system in use does not exactly match each configuration and may need reshaping. This operation is easy to apply for distributed systems by using discrete preset settings for each loudspeaker.

On the contrary, it remains harder to reshape a line source response which changes much with various configurations. As preset parameters do not compensate for the laws of physics in array coupling, System Engineers have to re-tune the tonal balance of their systems with no guidance.

As early as 1992, L-ACOUSTICS® identified the multiple factors governing the changes in the frequency response of a WST® line source design [1-3]. With the evolution of DSP technology, L-ACOUSTICS® has now developed the exclusive **Array Morphing** tool. It is part of LA NETWORK MANAGER software (version 1.2 and latest) and allows quick, accurate, and predictable global settings for any L-ACOUSTICS® WST® system.

2 PRESET CONSTRUCTION

2.1 Fundamentals

The final frequency response of a loudspeaker not only depends on the enclosure and transducer characteristics but also on the preset which is the final electronic transducer optimization.

The preset contains the DSP parameters for controlling the bandwidth (shelving and X-over filtering) and power resources for each frequency section. The goal is to optimize resources for each section by ensuring individual transducer thermal and mechanical protection as well as offering the user the desired frequency contour for a given application.

In this way, the preset contributes to the acoustic performance of the loudspeaker. These can be compared to the motor of a car: this organ develops power. But a question remains: which envelope to choose to make the car attractive and suitable for practical use?

While transducers and amplification define the power and the bandwidth abilities of the speaker system, the enclosure design and the preset parameters optimize the acoustic performance. In addition, the preset includes complementary EQ to provide the sonic signature of the loudspeaker (typically the sonic envelope for the application).

As a result, a preset construction addresses the acoustic performance as well as the sonic signature of a loudspeaker. Both aspects are independent, since a speaker may yield excellent acoustic performance and poor sonic signature. The contrary is also possible.

To obtain excellent results, it is necessary to take into account all the parameters governing the acoustics of a loudspeaker system. These parameters are different for each system type, configuration and use. These parameters have been identified and classified by L-ACOUSTICS® in the case of line source array systems.

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2.2 Line source array parameters

The transfer function of a line source array (denoted $\mathcal{T}_{\text{array}}$) is governed by three sets of parameters respectively linked to the environmental conditions, system application and array geometry (array size, array curvature, and listening distance) as it is shown in the following formula:

$$\mathcal{T}_{\text{array}} = \mathcal{T}_{\text{env}} \times \mathcal{T}_{\text{app}} \times \left[\mathcal{T}_{\text{size}} \times \mathcal{T}_{\text{curv}} \times \mathcal{T}_{\text{dist}}\right]$$

$\mathcal{T}_{\text{env}}$ denotes the environmental influence due to room acoustics and air absorption. These effects may be compensated using the integrated **Contour EQ** setting tool in LA NETWORK MANAGER or an external EQ station.

$\mathcal{T}_{\text{app}}$ is a function of the product type, system configuration, and preset that have been selected to match a particular application. As an example, the frequency responses of three different systems are given in Figure 1 (after SPL rescaling to make the comparisons easier). They have been obtained by successively applying the $\mathcal{T}_{\text{app}}$ transfer function of each system to a pink noise signal:

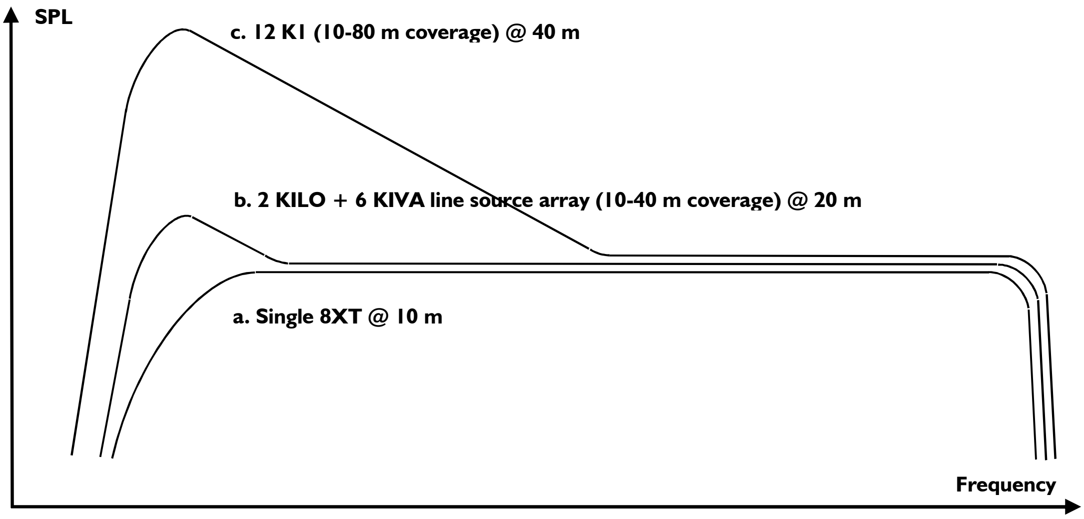

Figure 1: Three representative system frequency responses

- **a.** Single coaxial speakers (or 2-KIVA or 1-KARA fill line source arrays) for distributed applications. The [FILL] preset has been selected to obtain a “flat” response in free field conditions. Two other presets are available: [FRONT] for FOH application and [MONITOR] to match half-space conditions (last for coaxial only).
- **b.** KIVA (or KARA) line source array with low frequency extension (KILO or SB18). The low frequency response can be from “flat” to slightly enhanced. Such a system is modular as it can match different applications (theatre, arena, stadium) for all audience sizes.
- **c.** K1 (or KUDO or V-DOSC) line source array for concert-touring applications with large audiences. The low frequency response is enhanced to satisfy near-field experience at any distance. The presets used to obtain such a response are based on the “12 V-DOSC (10-80 m coverage) @ 40 m” response curve that has become the L-ACOUSTICS® reference over 15 years of international feedback experience.

$\mathcal{T}_{\text{size}}$, $\mathcal{T}_{\text{curv}}$, and $\mathcal{T}_{\text{dist}}$ are respectively linked to the array size, array curvature, and listening distance. Their influence will be discussed in the following section.

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3 LINE SOURCE ARRAY CONTOUR RECALL

For more detail on this subject, please refer to [1] or [2], or attend a WST® training course.

Any line source array provides a wave propagation mode yielding a -3 dB SPL decrease per doubling of distance in the HF frequency domain and -6 dB in the LF domain. The frequency of transition depends on the size of the line source. For example, the Figure 2a shows the evolution of the frequency response of a 12-V-DOSC system when doubling the listening distance three times (d, 2d, 4d, and 8d).

If we now ignore the 3 dB loss in the HF region, we obtain the four relative curves of Figure 2b. We observe that the **LF domain** contribution is enhanced as the **observation distance decreases** from far to close.

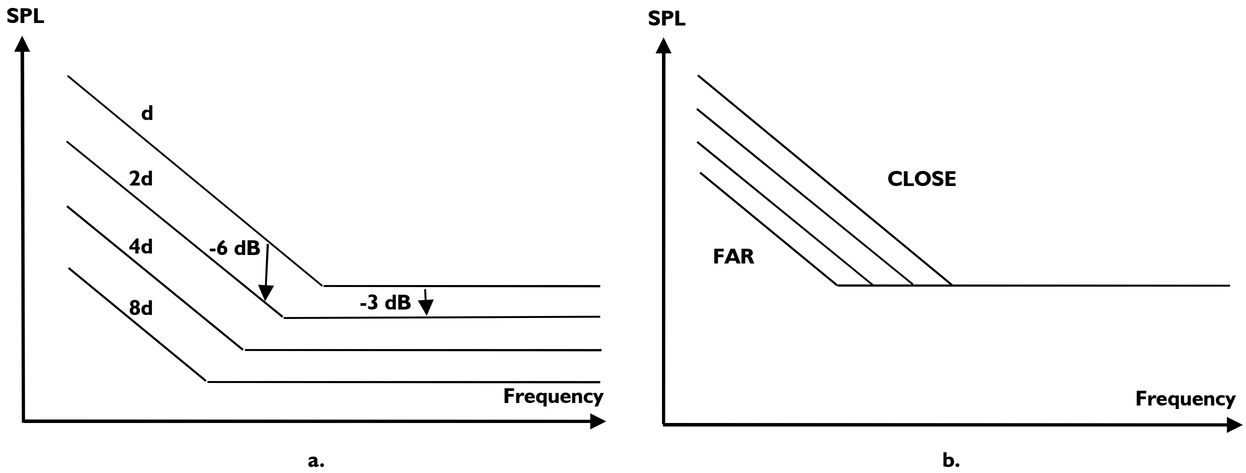

Figure 2: 12-V-DOSC array contour versus observation distance

In the same way we can observe that the LF domain contribution is enhanced as the **array size** (number of enclosures) or **curvature** (inter-enclosure angles) **increases**, as it is respectively shown in Figure 3a and Figure 3b.

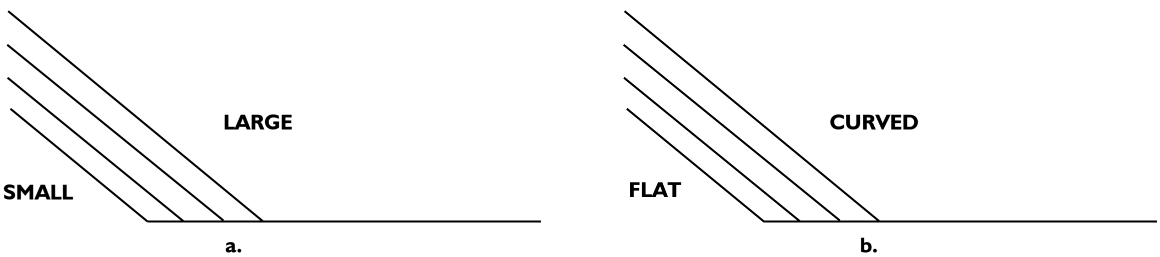

Figure 3: 12-V-DOSC array contour versus size and curvature

As shown in the above diagrams, it can be demonstrated that the three geometrical factors governing the frequency response of a line source array induce similar effects. As a size increase acts like a curvature increase or a distance reduction we conclude that these three factors are linked and can virtually be addressed by the same action.

Based on this original observation which results from the physics of line sources, L-ACOUSTICS® has developed the first frequency response setting tool for line source arrays. This tool is called **Array Morphing** and will allow the System Engineer to easily achieve the same tonal balance for different geometry line source arrays and combine different line source speakers in the same installation while offering the same sonic signature.

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4 ARRAY MORPHING

4.1 Overview

The **Array Morphing** tool is associated to a **Group** of LA amplified controllers (**Units**), and uniformly applies to all of them. It can be accessed from the **Tuning Page** of LA NETWORK MANAGER 2 by clicking on any **Group** present on the **Workspace**. For example, Figure 4 shows the **Array Morphing** panel associated to **Group 1**.

Array Morphing is composed of two parameters called **Zoom Factor** and **LF Contour** which modify the frequency response curve displayed in red. The dotted line represents the relative frequency response curve of the system in use when no correction is applied (**Zoom Factor** and **LF Contour** are turned off). The fact that any system frequency response can be represented by this line is justified by both following points:

- All L-ACOUSTICS® presets have been created using the same approach.
- Using a relative scale makes possible the use of the same display for all speakers.

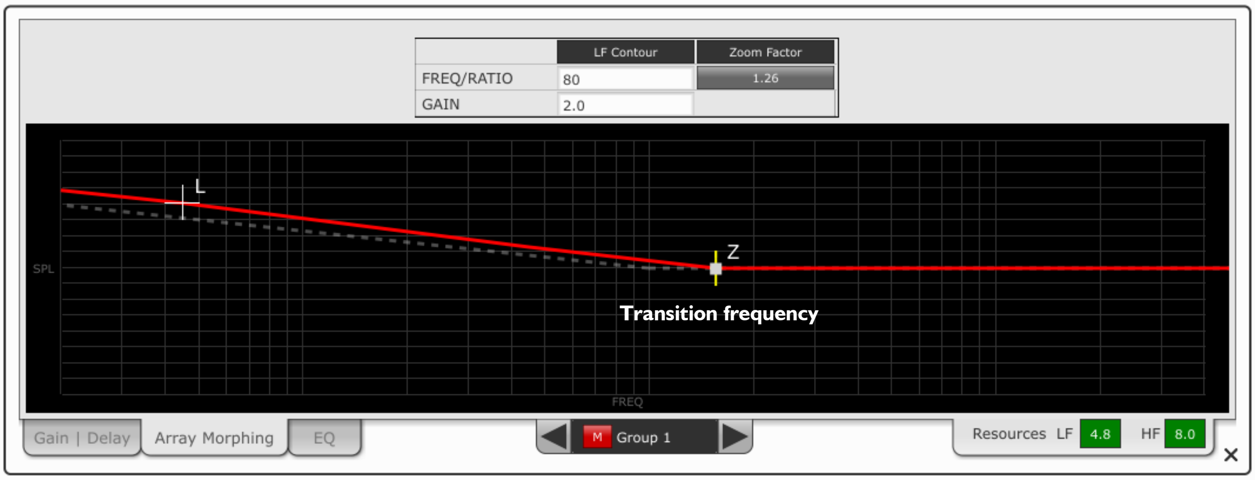

Figure 4: Array Morphing panel

The reference presets for concert-touring systems lead to contours of same type as Figure 1c.
The reference presets for modular line sources lead to contours of same type as Figure 1b.
The **Array Morphing** tool does not apply to single distributed speakers, except for "art" effects.

Always apply the **Array Morphing** settings to **all** enclosures of a same array to avoid poor acoustic results. For that, check that the corresponding **Units** are part of the **Group** for which the current settings apply.

The headroom is displayed in real-time in the **Resources Cells** at the bottom right of the **Array Morphing** panel (see Figure 4). Always verify that the headroom is in a safe range for all **Units**.

Refer to the **LA NETWORK MANAGER tutorial** for both operations.

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4.2 Zoom Factor setting

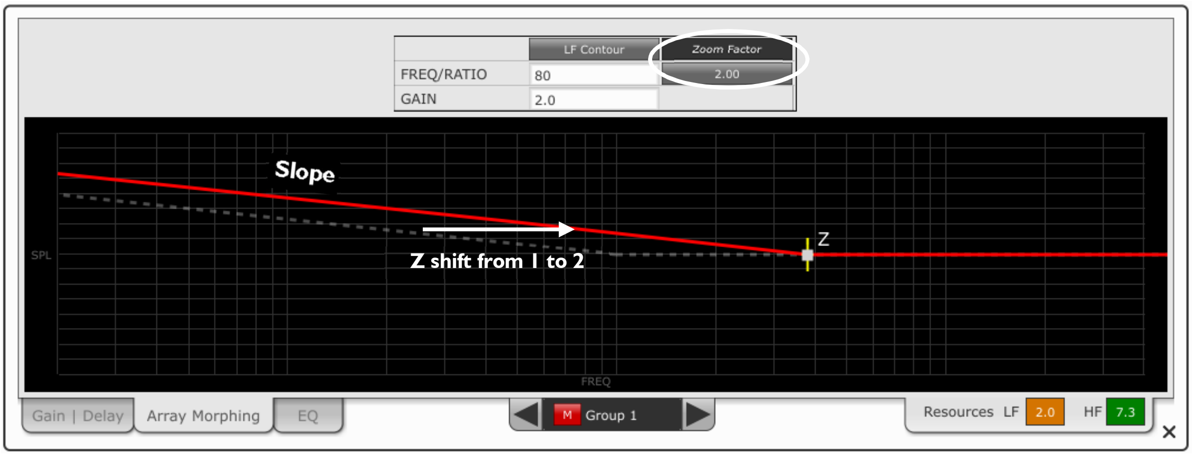
Zoom Factor is a single parameter which literally allows the line source to sound either bigger (inv. smaller) or closer (inv. further away) with a continuous zoom magnitude setting tool. Values for Z (**Zoom Factor**) are comprised between 0.18 and 5.62:

- Z=1 is the neutral setting and has no effect on the frequency response curve (dotted line on Figure 5).
- Z > 1 acts as a telephoto lens (array looks bigger, inter-enclosure angles appear larger, listening distance looks shorter). The corresponding response curve has transition frequency shifted towards right (Figure 5a). This setting will enhance the LF contribution and is useful for additional LF contour when using an ultra-compact system.
- Z < 1 acts as a wide angle photo lens (array looks shorter, inter-enclosure angles appear smaller, listening distance looks longer). The corresponding response curve has transition frequency shifted towards left (Figure 5b). This setting will "flatten" the frequency response curve and is useful for classical or corporate applications when using a large format system.

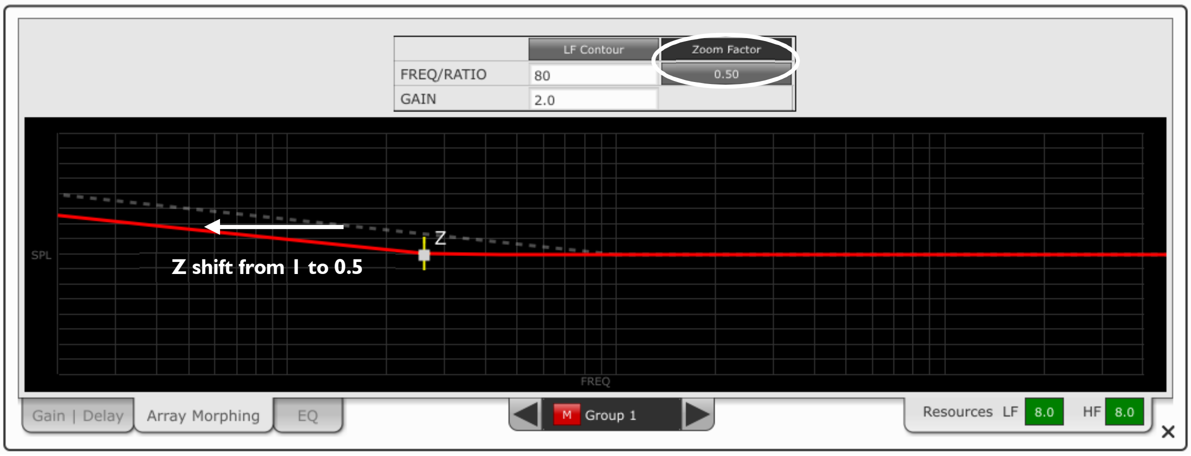
i Setting Z > 1 will reduce the LF headroom for all loudspeakers associated to the current **Group**. For example, setting Z = 2 will induce a 6 dB headroom reduction.

Inversely, setting Z <1 will enhance the LF headroom.

Zoom Factor uses a realistic multiplier scale. For example, setting Z = 2 will virtually multiply the array size by 2, divide the observation distance by 2, or double the vertical coverage. Inversely, setting Z = 0.5 (the inverse of 2) will divide the array size by 2, multiply the observation distance by 2, or divide the vertical coverage by 2.



a.



b.

Figure 5: Zoom Factor setting

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4.3 LF Contour setting

LF Contour is a single low frequency shelving tool. The FREQuency can be set between 35 and 180 Hz and the GAIN between -15 and +10 dB.

The GAIN parameter must be used very carefully in order to avoid severe system headroom reduction.

Setting GAIN > 0 will reduce the LF headroom for all loudspeakers associated to the current **Group**.

Exhaustive presentation of the **LF Contour** tool cannot be done because the setting possibilities are numerous. However, it is highly recommended to follow one of the following two guidelines:

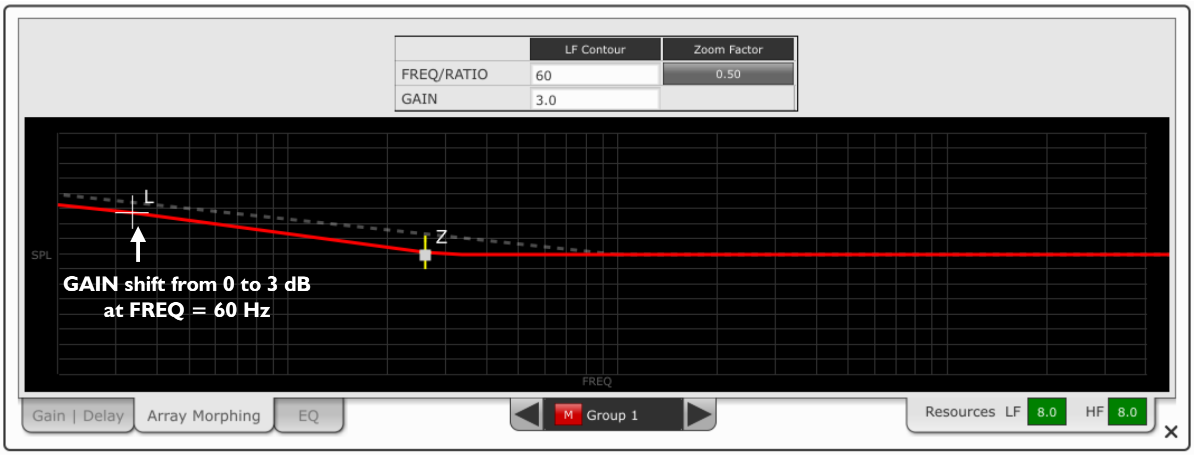
LF Contour as an independent tool

The **LF Contour** tool can be used with the **Zoom Factor** tool inactive (turned off or Z = 1). Both FREQ and GAIN parameters can be adjusted to obtain the expected frequency response curve.

LF Contour as a complementary tool to refine the Zoom Factor settings

After the most suitable **Zoom Factor** value has been selected, set both **LF Contour** parameters. It is recommended to start with the lowest frequency value (FREQ = 35 Hz) and observe the GAIN setting effects on the response curve. The FREQ value can then be adjusted to shape the desired LF response of the line source array.

- Set GAIN > 0 at a low FREQ value (near 35 Hz) to recover more LF level especially if Z < 1 (see Figure 6a).
- Set a larger FREQ value (near 180 Hz) to recover a larger domain, even up to the entire Sub-Low-Mid original response (Figure 6b).
- Set GAIN < 0 to reach a “flat” frequency response (see Figure 6c) when using a concert-touring system.



a.

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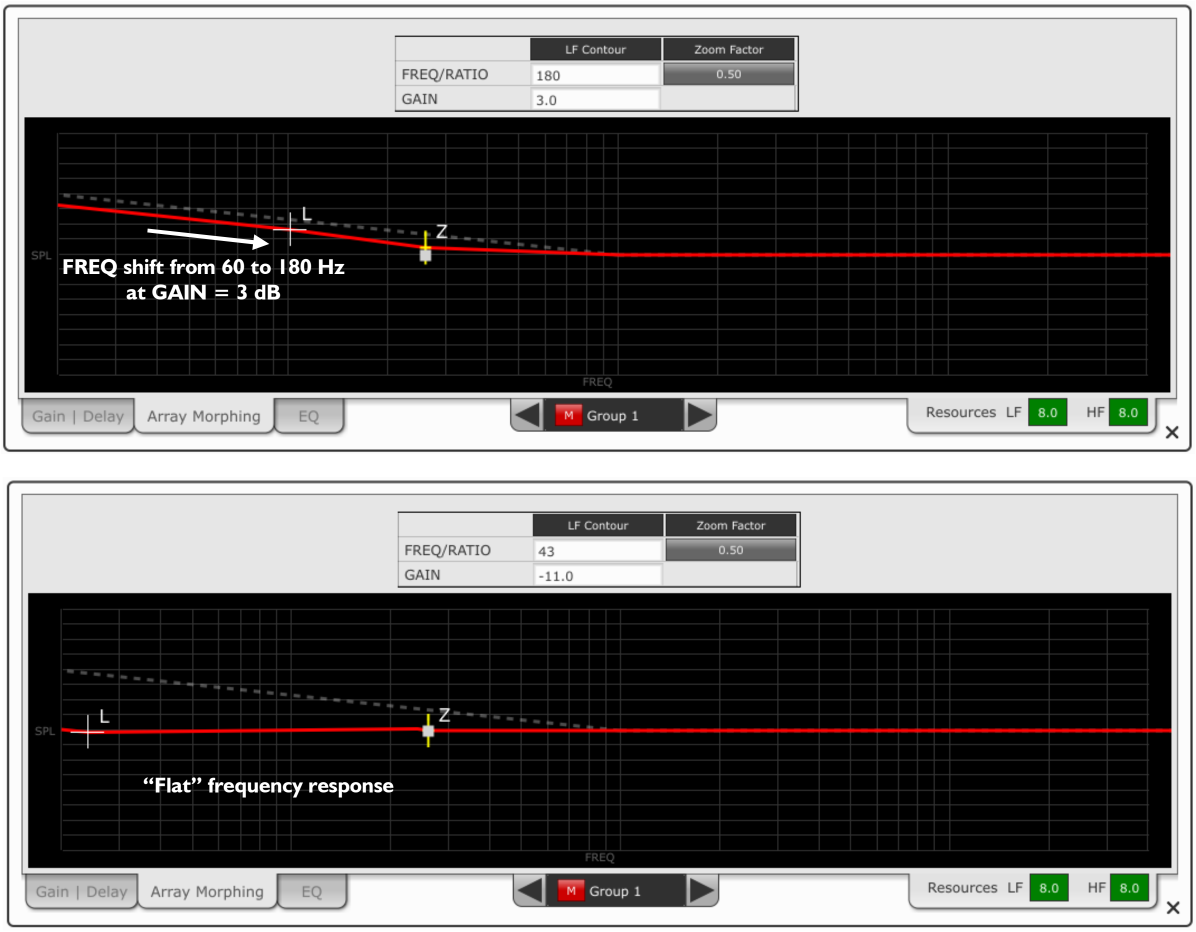

b.

c.

Figure 6: Setting the FREQ and GAIN parameters

5 CONCLUSION

Array Morphing is the first frequency response setting tool addressed to line source arrays. Used along with a factory preset of the LA4 or LA8 PRESET LIBRARY (refer to the **LA4** or **LA8 PRESET LIBRARY user manual**) it allows the System Engineer to virtually re-dimension any array (within the limits of the power resources) and specifically addresses the following:

- Smoothly adjust the frequency response of a line source array and compensate for different array geometries and conditions of use.
- Provide the same sonic signature to all L-ACOUSTICS® line source systems used in the same installation, and approach a reference standardized frequency response when desirable.
- Offer frequency response flexibility to adapt to various applications: from speech & classical music ("flat" response) to live rock music ("enhanced LF response").

REFERENCES

[1] M. Urban, C. Heil and P. Bauman, "Wavefront Sculpture Technology", *J. Audio Eng. Soc.,* Vol. 51, No. 10, 2003 October.

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[3] C. Heil and M. Urban, "Sound Fields Radiated by Multiple Sound Source Arrays", 92nd Convention of the Audio Engineering Society, *J. Audio Eng. Soc. (Abstracts)*, vol. 40, p. 440 (1992 May), preprint 3269.

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